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# Improvement of the Traffic Control on Complex Crossroads via Sending Randomized Recommendations to Drivers

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**Abstract**: The efficient use of signalized crossroads, especially intersections of multi-lane highways playing a great role in the urban traffic, demands not only the adequate control by traffic lights regulation but rational adaptation of the drivers' totality to current traffic organization and control as well. The latter results from their complex structure and traffic organization on them when some lanes within an intersection split and/or merge with the other ones and their passage is regulated individually. Besides, changes of lane counts on entrance and exit roads is typical. The lack of visible indicators helping drivers in their error-free rational lane choice may be overcome by the traffic control system endowed with the function of the advice-tick system for the drivers' totality. The proposed way to elaborate proper recommendations is based on calculation of the optimal distribution of vehicles between possible routes according to the current intensity of entering traffic flows in all passage directions obtained from the monitoring data. To approach this ideal distribution it is proposed to send impersonal recommendations to drivers of approaching vehicles depending on their desired passage directions; these recommendations must randomly change in time according to the determined distribution since some admissible directions must be splitted between certain routes in the calculated proportion. The proposed control method can significantly reduce improper lane choice by drivers, including their principal errors not allowing them to reach the needed road and so increase the intersection capacity utilization and reduce traffic delays.

***Keywords***: road traffic control, traffic organization, multi-lane highway, road intersection, traffic flows, driver behavior, simulation

## 1. INTRODUCTION

Road junctions, especially junctions of multi-lane roads, play a very significant role in the urban traffic and, if used inefficiently, they can practically block the traffic in large segments of road networks. Only a small part of them are designed as multi-layer road constructions including bridges and/or tunnels. Most junctions are single-layer intersections and in the cases of the medium or high traffic they are regulated by the traffic lights.

For the reason of safety the organization of the traffic through a certain intersection foresees the separations of routes between phases of the traffic light cycle (TLC). Routes' crossing on each phase is forbidden and they try to exclude or minimize routes' merging as well. Each phase of the traffic light cycle serves a certain set of passage directions with individual traffic intensities of each of them. So the determination of the TLC phases must provide the possibility for all admitted directions to pass through the intersection with an average intensity of the entering traffic flow.

However, even the best adaptation of the traffic light regulation parameters to the intensity of incoming flows and their distribution between the permitted directions of the

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intersection passage (both factors express locally the social demand for relocation within the city) may be insufficient for the most efficient implementation of the demand. This situation takes place if some directions may be passed by more than one route. Then the efficient use of the intersection throughput require the proper distribution of vehicles on these directions between these routes that may not be automatically reached by the drivers' totality self-organization because of the lack of visible indicators for their choices. It is especially difficult when some lanes within the intersection are branched into several lanes or, conversely, merge with other ones.

To cope with the situation, it is advisable to endow the traffic control system with the function of an intelligent advisor for drivers, the specific implementation of which at a given time and at a given intersection should be integrated with monitoring the local traffic situation and determining the parameters of the traffic light cycle on it. In this case, recommendations should be issued to the registered users of the intelligent driver assistance system, who, in order to receive the advice, must announce the direction they need to travel through the intersection. In order to approximate the distribution of vehicles by lanes to the most effective, these recommendations should be issued to each user individually, however based not on their personal data (the system only needs to know the type of each vehicle) but on statistical considerations.

## 2. BACKGROUND

This work is related to works on adaptive traffic control systems at the intersections. Works of this kind have been known since the 1970s [3] and continue to develop [1, 7, 10, 12, 19]. In theoretical terms, such works are based on some general idea of the road traffic at the intersection, which can be of one of the types: 1) empirical macroscopic, considering "portions" of traffic at the intersection as a whole, or 2) microscopic, implying reproduction of the individual vehicles' movement, which, the latter having the form of random streams, cellular automata or dynamical systems [4]. This work is based on the latter model type—the integral characteristics of the passage of vehicle flows through the intersection are supposed to be determined by calculating the trajectories of individual vehicles in the traffic flows [15, 16].

A number of works, both scientific and practical, are devoted to the structure of the intersection [5, 6, 9, 13, 14]. Its detailed presentation is necessary for the application of the methodology proposed in this article.

Finally, a number of new works is devoted to the opportunities offered by the information interaction both between the drivers in a vehicle group and between the drivers and the traffic control system.

The concepts of Advanced Driver Assistance Systems (ADAS), Adaptive Cruise Control (ACC) and even Connected Autonomous Vehicles (CAV) are being developed either individually or in combination [2, 11, 17, 18, 21]. Some features of the proposed systems have already been implemented in some advanced models of cars. It also solves the emerging problem of data transmission in communications between drivers of individual vehicles (V2V) and between drivers and the traffic control infrastructure or vice versa (V2I) [20]. On the other hand, the emerging opportunities to improve vehicle handling should lead to both the increased safety of their passengers and the improvement in the road situation in general. The latter mean better conditions for meeting social needs for movement in the city.

We focus on the new possibilities of V2I systems, but also note the usefulness of information interaction between drivers of neighboring vehicles for its more complete implementation.

## 3. PROBLEMS OF INDIVIDUAL AND SOCIAL ROUTE CHOICE FOR DRIVERS OF VEHICLES ON AN INTERSECTION OF MULTI-LANE ROADS

The vehicle driver in a big city faces a lot of various forms of traffic organization, especially on highway intersections. This fact may be seen from Fig. 3.1 showing the principal schemes of 15 from the 59 main junctions in the Moscow urban road network [8]. All these structures as well as 44 others are different.

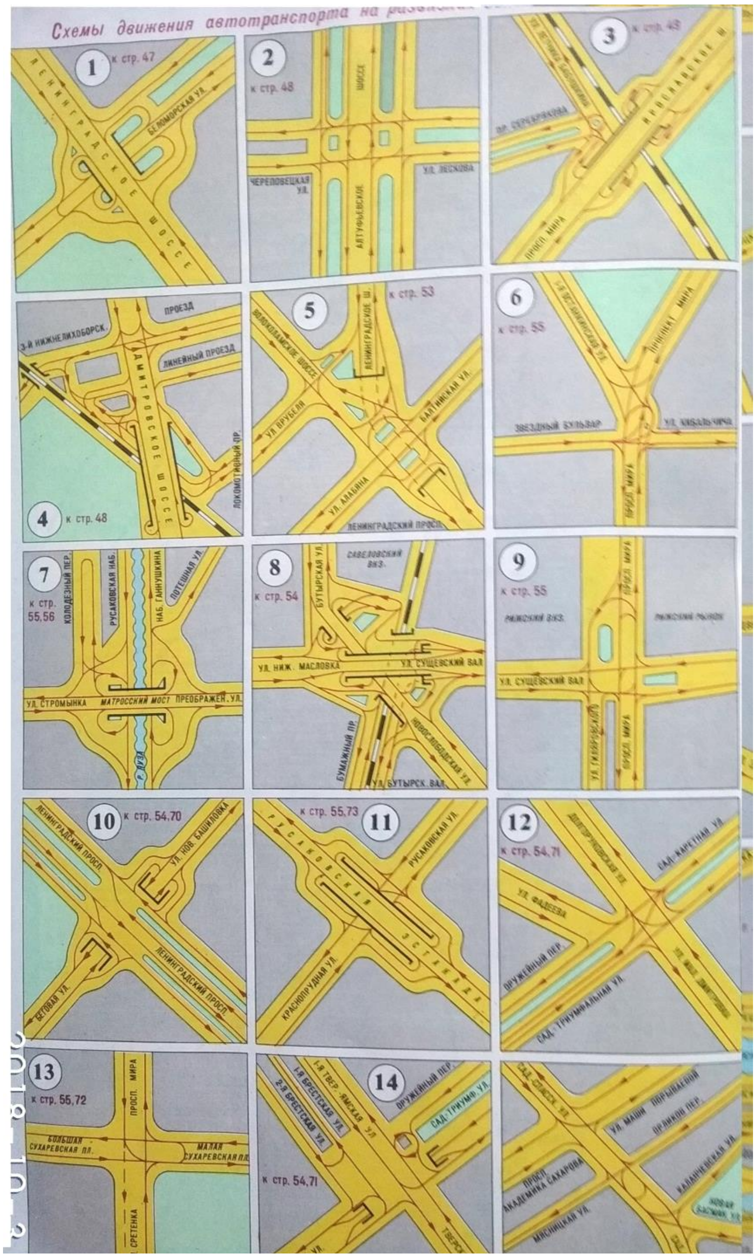


**Fig. 3.1.** Principal schemes of main road junctions in Moscow [8]

Besides, these principal schemes do not cover the entire set of variants for choosing by the drivers approximating these intersections and passing them since many passage directions are splitted into several lanes some of which branch and so serve more than one direction. The difference between the real traffic organization of a complex road junction and its representation in the Internet or on a printed map is demonstrated by Fig. 3.2 and 3.3. Markings on the road cover show the permitted directions of movement but it is often too late for a driver to make choice when seeing them.

 


**Fig. 3.2.** Principal scheme of the road junction on Serpukhovskaya Square

**Fig. 3.3.** Actual traffic organization of the road junction on Serpukhovskaya Square

In addition, typical traffic organization involves changing the number of lanes on the entry and exit roads when approaching the intersection. All the above mentioned makes sufficient difficulties for the drivers in their choices of paths. This choice is especially difficult if some passage directions are served by more than one lane. In this case each driver must answer the question what entry queue to join for passing the intersection in the minimal time.

The actual organization of traffic determines the choice of drivers (on each entry road) and the reasons for the particular choice. The latter can be: first of all, its correctness for the desired direction of movement; then the expectation of a faster crossing, and finally maximum safety and convenience. The first reason is relevant for every multi-lane entry road, the others only if there is more than one road for the desired travel direction.

Drivers who do not regularly pass a certain intersection of multi-lane roads may need assistance in choosing the correct lane in all cases. However, we only focus on cases where there is more than one route for some travel directions.

The totality of drivers' choices for the given TLC parameters determines the efficiency of the intersection throughput use that may be characterized by average delays in its passage. Such a choice is relatively simple only if the entrance lanes are strictly separated between directions, for every direction they are geometrically similar, and there are no merging points or at each TLC phase they are passed in the only one direction. In this case maintaining approximately equal lengths of queues in front of the entrance stop lines for a group of lanes serving the same direction leads to close values of delays for all these lanes and corresponding routes. Thus drivers can focus on the lengths of queues and — in the aggregate — ensure their alignment. In this case self-organization of the local driver community is useful for them all, but even then the choice of an individual driver is random. In other cases there are no visible landmarks for adapting the totality of drivers to the local road situation to achieve traffic efficiency. For example, in the typical case when one lane allows only driving straight ahead and the neighboring one — straight ahead and to the right, and the duration of the green phases for these lanes, as is often the case, is not the same.

In these complex cases that are typical for intersections of multi-lane highways it is very unlikely that a joint choice of drivers can provide favorable conditions for traffic through an intersection. An intelligent traffic management system should help drivers make choices in order to form an aggregate choice that will benefit most of them.

## 4. PROPOSED APPROACH

### *4.1 Methodology*

The aim of our research is to work out the concept of an advisory system for drivers affecting their behavior in the way that must improve the traffic passage through a definite signalized intersection. To reach the goal, the way of quantitative prognosis of traffic indices must be proposed linking it with the cumulative choice of the drivers' totality. Besides, we must determine the informational basis of the projected system.

In fact, the required indices of the traffic passage through a definite intersection depend on:

1. the static traffic organization of the intersection, i.e., the set of the permitted passage directions connecting some pairs of the entry and exit roads and the system of the routes through the intersection area corresponding to these directions;
2. the dynamic traffic organization of the intersection, or, in other words, the structural control, consisting in the separation of these roads among phases of the traffic lights cycle (a so-called phase-wise traffic separation scheme — TSS);
3. the parametric control of the intersection, i.e., the duration of each phase of the traffic light cycle;
4. the actual (or desired) average traffic intensity for each passage direction; it must be emphasized that the road traffic has the stochastic nature, so these intensities oscillate.

To elaborate the qualitative and quantitative attributes of the set of messages for drivers, the traffic control system must obtain and take into account the following information:

1. Representation of the existing traffic organization at the crossroads area on two levels. The first one means the set of pairs (an entry road, an exit road) that define the permitted passage directions. The second one is the detailed representation of the intersection including neighboring segments of entry and exit roads in the form of the oriented graph of all permitted routes through the crossroads area. Its arcs are axes of road lanes' segments and

nodes are of three types: 1) points of intersection of arcs, 2) stop lines on entries to the intersection or within it, 3) conditional borders of the intersection area on entry and exit roads. Notice that these data entirely define alternatives in the intersection passage for vehicles entering it by every road. Every possible route on this graph connecting a pair of entry and exit points may be used as a route through the intersection.

2. Separation of the routes between TLC phases in the form of TSS that is introduced to eliminate the danger of vehicles collision in the simultaneous passage of points of crossing and diminish this danger in the simultaneous passage of points of merging.

3. The average throughput of each active route on each TSS phase as a function of its duration must be established either from the traffic monitoring treatment or the computer simulation on the verified model.

4. The characteristic of current traffic flows to which the system of drivers' informing is being adapted is the existing (desired) intensity of traffic flows on each passage direction.

The implementation of the proposed idea principally consists in three items:

1. For known values of duration of each phase the ideal distribution among the proper lanes the vehicles incoming by each entry road for each passage direction . It must be performed by the solution of the below optimization problems.

2. If this ideal distribution is, nevertheless, unsatisfactory to meet the existing traffic demand, recommendations are made how to choose more efficient values of TLC phases' durations.

3. Finally, the way of formation of the stream of messages addressed individually (but impersonally) to drivers of approaching vehicles is being defined. It is aimed to the best attainable correspondence between the real distribution of vehicles along the routes and the ideal one.

### *4.2. Determination of dependencies that characterize quantitatively the route passage*

The separation of passage directions between TLC phases minimizes the interaction between traffic flows on different directions, although not entirely. Typical case of the vehicular traffic on a route during one green phase is the movement of a chain of vehicles (cluster) with the minimal safe distance between subsequent vehicles. Each cluster primarily consists of cars that formed an immobile queue up to the moment of the green phase beginning; if the queue is relatively short, extra cars join the cluster that does not change the cluster structure. Nevertheless, quantitative indices of the clusters change from one cycle to another one because of many random factors, such as the distribution of vehicles' types as well as psycho-physiological types of vehicles' drivers in the cluster. An example of fluctuations in counts of passed vehicles on a definite lane for 5 subsequent cycles is shown in Table 4.1.

**Table 4.1.** Observation data of the route passage by traffic flows during several cycles

| Cycle number | The number of vehicles that crossed the stop line, for time intervals ( $n_i(T)$ ) | | | |
|---|---|---|---|---|
| | *0–10 sec.* | *10–20 sec.* | *20–30 sec.* | *0–30 sec.* |
| 1 | 5 | 5 | 4 | 14 |
| 2 | 3 | 4 | 3 | 10 |
| 3 | 3 | 5 | 3 | 11 |
| 4 | 3 | 5 | 4 | 12 |
| 5 | 4 | 4 | 4 | 12 |

Such data, although in much greater amount, enable us to define the required dependences. The maximum average number of vehicles passing a definite $i$-th route for a given time interval is a definite value $n_{\max i}(T)$ with a certain composition of the traffic flow on it (i.e., a certain distribution of types of vehicles in the traffic flow) and some other influencing factors (whether, illumination). Based only on the data presented in Table 4.1, we may define $n_{\max i}(T)$ as 3.6 for $T$=10 s, as 8.2 for $T$=20 s and as 11.8 for $T$=30 s. For intermediate values of $T$ the required values of $n_{\max i}(T)$ may be assessed by interpolation and for $T$>30 s by extrapolation. However, their assessment by simulation on a model with correctly identified parameters seems preferable.

If the $i$-th route branches and, thus, serves multiple passage directions $J_{\mathrm{PD}i}$, then $n_{\max i}(T)$ depends on the proportion of vehicles' separation between the passage directions, i.e., on the values of $Q_{ij}/Q_i$ where $Q_{ij}$ is the traffic flow intensity for the direction $j$ and $Q_i$ is the sum of them. For more concise notation this dependence may be written as $n_{\max i}(T,\{Q_{ij}, j\in J_{\mathrm{PD}i}\})$. For the overwhelming majority of signalized intersections each route branches one time only into two ones; so only one value of the type $Q_{ij}/Q_i$ determines $n_{\max i}(T,\{Q_{ij}, j\in J_{\mathrm{PD}i}\})$ and we may choose the fraction of the number of vehicles moving in the straight direction after the branching point ($f_{\mathrm{STR}\,i}$) for this role. To establish the values of $n_{\max i}$ we must split all obtained data of

$$n_i(T) = n_{\mathrm{STR}\,i}(T) + n_{\mathrm{TURN}\,i}(T) \tag{4.1}$$

into classes with close values of $f_{\mathrm{STR}\,i} = n_{\mathrm{STR}\,i}(T)/n_i(T)$. It looks very likely that the data set of observations may be insufficient for a reliable estimate and simulation must be used.

The introduced dependences are related to the distribution of vehicles entering the intersection along one road. It is sufficient if the current TSS does not involve any active merge point that is the most common traffic organization. The case of active merging points is more complicated and demands further investigations.

### *4.3 Calculation of the optimal distribution of vehicles among the routes according to the known intensity and structure of input traffic flows*

The problem under consideration is solved in a certain context: for a definite TSS and given durations of TLC phases. The duration of the TLC and its $r$-th phase are denoted further, respectively, by $T_{\mathrm{TLC}}$ and $T_{\mathrm{P}\,r}$.

Let $R_i$ be the set of TLC phases on which the $i$-th route is passed. Let the set of passage directions for vehicles entering the crossroads area along the entrance road $k$ be $J_k$ and for the passage direction $j$ the set of routes $I_{kj}$ is used. The set of routes for all $j\in J_k$ is denoted by $I_k$. Let $Q_{\mathrm{PD}\,j}$ be the actual or desired traffic flow intensity for the passage direction $j\in J_k$. Our aim for each entrance road $k$ is to distribute all $Q_{\mathrm{PD}\,j}$, $j\in J_k$, in time and space, namely between routes from $I_{kj}$ and green phases for these routes in the optimal way, i.e., to determine the optimal values of $Q_{ijr}$ where

$$\sum_{i\in I_{kj}}\sum_{r\in R_i} Q_{ijr} = Q_{\mathrm{PD}j},\ j\in J_k. \tag{4.2}$$

Such a distribution is feasible if the throughput of each route is not smaller than the intensity of vehicles' appearance in its beginning, so

$$T_{\mathrm{TLC}}\sum_{r\in R_i}\Big(\sum_{j\in J_{\mathrm{PD}i}} Q_{ijr}\Big)/n_{\max i}(T_{\mathrm{P}\,r},\{Q_{ijr}, j\in J_{\mathrm{PD}i}\}) = 1-\sigma_i,\quad \sigma_i\ge 0,\ i\in I_k. \tag{4.3}$$

$\sigma_i$ may be treated as the throughput reserve indicator for the passage direction $i\in I_k$. So the target value is the total reserve indicator $\sigma_{0k}$ for all passage directions for which

$$\sigma_i \ge \sigma_{0k},\ i\in I_k. \tag{4.4}$$

 

The introduced optimization problem consists in maximizing $\sigma_{0k}$ under restrictions (4.2)–(4.4). The problem in question is a nonlinear programming problem. It must be emphasized that dependences $n_{\max i}(T, \{Q_{ij}, j \in J_{\mathrm{PD}i}\})$ expressing average maximal numbers of passing vehicles are not integer-valued due to the stochastic nature of the traffic and are represented by smooth functions.

The case when the condition

$$\sigma_{0k} \geq 0 \qquad (4.5)$$

is satisfied for all directions is favorable and does not require changes of durations of the TLC phases. Otherwise, the problem of these rational changes emerges: to increase the phase duration causing the violation of (4) for some entrance roads; it demands decreasing the rest ones. If we are sure that the calculated optimal distributions of vehicles between routes are attainable, then it is reasonable to determine them and phase durations simultaneously. Thus the following problem may be solved: to maximize $\sigma_0$ under restrictions (4.2), (4.3) and

$$\sigma_i \geq \sigma_0, \quad i \in I_k. \ j \in J_k, \qquad (4.6)$$

for all $k$=1,…, $K$.

To illustrate the proposed solution, a specific example is analyzed, namely two highly curved parallel lanes shown in the rightmost part of Fig. 3.3; they implement the turn from the inside of the Garden Ring to the outside. According to the existing traffic organization the traffic flow from Valovaya Street is separated between these lanes that are passed simultaneously.

The following table provides the necessary data for the case in question. Two opposite factors, namely, a greater curvature and a smaller length of the left lane, determine the specific form of dependences obtained from observational data.

**Table 4.2.** Dependences $n_{\max i}(T)$ for two parallel curves

| **Lane** | **The average number of vehicles that crossed the stop line during the specified green phase duration** | | | | | |
|---|---|---|---|---|---|---|
| | ***5 s*** | ***10 s*** | ***15 s*** | ***20 s*** | ***25 s*** | ***30 s*** |
| Left | 1.29 | 3.14 | 4.71 | 6.29 | 7.71 | 8.99 |
| Right | 1.71 | 3.71 | 5.43 | 7.02 | 8.01 | 9.00 |

It follows from (4.2)–(4.4) that in this case the optimal distribution of vehicles between the lines must satisfy the condition

$$T_{\mathrm{TLC}} Q_{11} / n_{\max 1}(T_{\mathrm{P1}}) = T_{\mathrm{TLC}} Q_{21} / n_{\max 2}(T_{\mathrm{P1}}) = 1 - \sigma_1. \qquad (4.7)$$

The necessary availability of the throughput reserve requires satisfying the condition

$$n_{\max 1}(T_{\mathrm{P1}}) + n_{\max 2}(T_{\mathrm{P1}}) \geq T_{\mathrm{TLC}} Q_{\mathrm{PD1}}. \qquad (4.8)$$

Then we have $\sigma_i \geq 0$ in (4.7). So if $T_{\mathrm{P1}} = 15$ and $T_{\mathrm{TLC}} = 30$, then the maximal incoming flow may be not greater than 10.14/30=0.338 vehicles per second. The temporal headway is slightly less 3 s (its minimal value for the most intense single-lane traffic flow is about 2 s). Most importantly, appearing vehicles must be distributed between the left and right lanes when entering the intersection in the proportion 4.71: 5.43, or 46.4% to the left and 53.6% to the right. In reality, the distribution of appearing vehicles between lanes changes randomly. Certainly, the optimal proportion cannot be achieved with deterministic messages. For the case with $T_{\mathrm{P1}} = 30$ s practically the same amounts of vehicles should join both queues but it is only a specific situation.

If the straight-line flow is divided between the left and right lanes, and the flow on the right passes only along the right lane, then the conditions must be satisfied

$$T_{\mathrm{TLC}} * (Q_{21} + Q_{22}) / n_{\max 2}(T_{\mathrm{P1}}, Q_{12} / (Q_{21} + Q_{22})) = 1 - \sigma_2,\ \sigma_2 \geq 0, \tag{4.9}$$

$$T_{\mathrm{TLC}} Q_{11} / n_{\max 1}(T_{\mathrm{P1}}) = 1 - \sigma_1, \qquad \sigma_1 \geq 0, \tag{4.10}$$

$$Q_{11} + Q_{21} = Q_{\mathrm{PD1}}, \quad Q_{22} = Q_{\mathrm{PD2}}, \tag{4.11}$$

and the optimization criterion may be expressed as maximization of $\min\{\sigma_1, \sigma_2\}$.

### *4.3. Generation of messages for drivers*

It follows from the above that the best situation for the crossroads passage in all directions is when each entry queue in each lane is a sequence of clusters corresponding to subsequent green phases for this lane, with each cluster consisting of the calculated numbers of vehicles. Besides, for branching lanes there must be a definite share of vehicles for each possible direction in every cluster. However, the exact match between the reality and the calculated deterministic distributions is unattainable because of the stochastic nature of the urban vehicular traffic. E.g., in (1) it is supposed to distribute $T_{\mathrm{TLC}} Q_j$ vehicles that must drive up to the intersection for one cycle for passing the *j*-th direction. In fact, it is only a mean value.

Nevertheless, the calculated distribution may be obtained on average through randomly generated messages. Problems (1)–(3) yield values that admit their direct utilization for forming the stream of messages. They are the shares of routes implementing a certain passage direction (in the general case, for a certain TLC phase). If the *j*-th direction is passed on the single phase *R* (the most common case) along two routes, 1 and 2, then these shares are constant in time and equal to $q_1 = Q_{1jR} / Q_{\mathrm{PD}j}$ and $q_2 = Q_{2jR} / Q_{\mathrm{PD}j}$, respectively. Then the recommendations to go along the 1st and the 2nd routes must be issued with probabilities $q_1$ and $q_2$. It is important that each driver would receive the message only one time; besides, the message must be sent and received well in advance to let enough time for maneuvers aimed at changing lanes. Just the same situation takes place if all routes for a definite direction are passed on two successive phases; in this case the two phases must be united in (2). Sending messages in the form: “if you drive straight then choose the second lane on the left; if you turn left then…” the advisory system does not need any information from individual drivers.

In other cases the share of routes differs for phases. Then values of route shares used in messages must change in time. We suppose that the most reliable way to define moments of switching is to link them with the count of vehicles after the previous switching. We assume that after appearing the average number of vehicles passing the intersection in the definite direction for one future phase that next vehicles will pass the intersection in the next phase and use for them respective values of shares. Then, a minimal feedback from drivers is required: everyone must inform whether he intends to go straight or to turn left or right.

В остальных случаях доли маршрутов для направления проезда перекрестка различается по фазам. Тогда значения долей каждого маршрута в приходящем потоке, используемые при формировании сообщений, должны меняться во времени. Для этого нужно разделить последовательности подъезжающих ТС на порции, соответствующие количеству ТС, прошедших на предыдущей фазе и по этой последней фазе определять требуемые доли для новой порции ТС. Потребуется также минимальная обратная связь от водителей: каждый должен сообщить, намерен ли он ехать прямо или повернуть налево или направо.

 

In other cases, the shares of routes for some directions of the intersection passage differ in cycles and phases. Then the values of the shares of each route in the incoming stream, used in the formation of messages, must change over time. To do this, it is necessary to divide the sequences of approaching vehicles into portions corresponding to the number of vehicles that passed in the previous phase and determine the required shares for a new portion of the vehicle from this last phase. Minimal feedback from drivers will also be required: everyone must indicate whether he intends to go straight or turn left or right.

## 5. EXISTING LIMITATIONS FOR THE APPLICATION OF THE PROPOSED METHODOLOGY AND WAYS TO OVERCOME THEM

Although there are no principal obstacles to implement a test version of the proposed advice-tick system, the initial number of its users may be very small and its effect as well, so it would be difficult to demonstrate practically the benefits of its implementation.

On the other hand, full-scale experiments at a certain intersection can be carried out with vehicles whose drivers have agreed to participate in the experiment.. Video fixation of the experiment must convince other drivers to follow the recommendations of the proposed advice-tick system.

To achieve the real usefulness of the proposed approach, its implementation on its initial stage requires both some perfections of its methodology and notably extra means of monitoring and information exchange. The technical aim is to maintain the actual distributions of vehicles between routes for each direction close to the optimal ones. it is necessary to establish in real time: 1) the share of drivers who receive messages and use them; 2) the actual distributions between the routes of vehicles whose drivers do not use the proposed advice-tick system. Then the identification of vehicles in the intersection area as driven by the users and non-users is required.

## 6. CONCLUSION

The urban road traffic is a complex phenomenon including technical, informational, ecological and socio-psychological aspects, but often it does not meet the present day requirements. Their significance for all these aspects is great. So efforts to improve it are reasonable.

The present paper puts forward both a new concept and a formal method for its implementation, and seems promising in some aspects. Based on modern achievements in control theory, traffic modeling and infocommunication technologies, it can be implemented in the near future.

For the effective use of the intersection throughput, it is necessary both to develop an adequate control by the traffic lights regulation and to achieve rational behavior of drivers for the current organization and traffic control.

The proposed approach is theoretically developed for the case when the traffic organization at the intersection excludes active points of route merging. This is a more common case, but merging routes is also used somewhere. Besides, a driver having intention to change the lane may not have a success, especially in the case of heavy traffic. However, the congested traffic causes so many difficulties that only a system of measures at many levels can overcome or rather mitigate them. At any rate, these aspects require consideration in further research.

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